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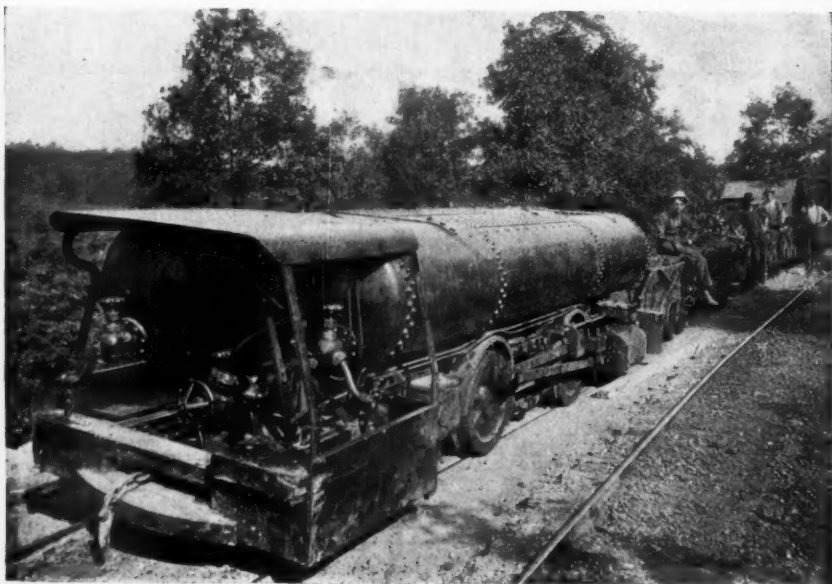
# Compressed Air

DEVOTED TO THE USEFUL APPLICATION  
OF COMPRESSED AIR.

VOL. IV.

NEW YORK, APRIL, 1899.

No. 2



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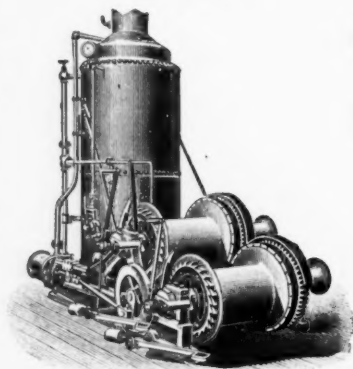
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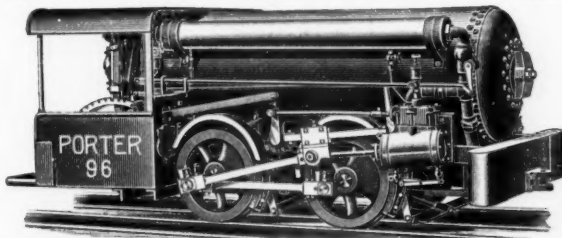
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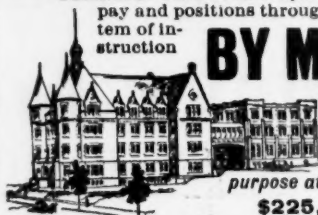
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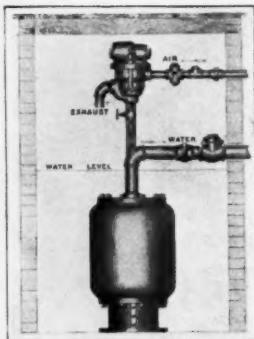
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00.....	capacity.....	$\frac{3}{16}$ in.....	weight.....	4 lbs.
0.....	"	$\frac{1}{2}$ in.....	"	10 $\frac{1}{2}$ lbs.
0 extra	"	$\frac{3}{4}$ in.....	"	15 lbs.
1.....	"	1 in.....	"	35 lbs.
1 extra	"	1 $\frac{1}{2}$ in.....	"	49 lbs.

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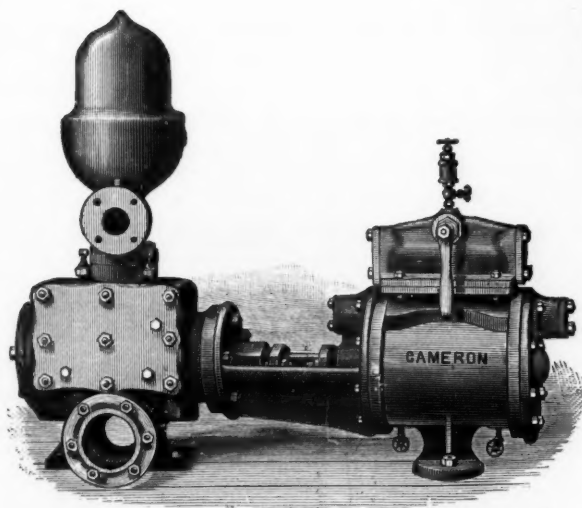
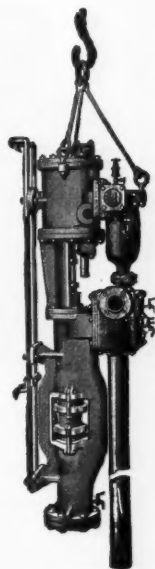
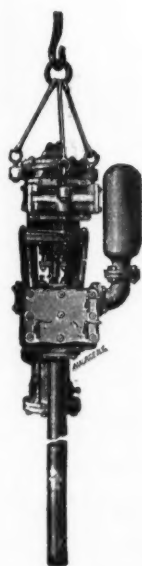
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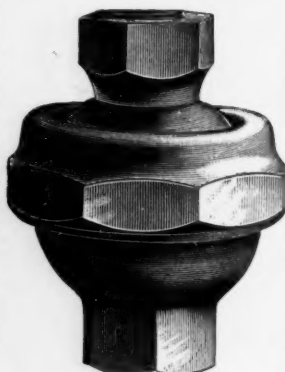
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# Compressed Air.

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

W. L. SAUNDERS, - - Editor and Proprietor  
A. E. KENNEY, - - - Managing Editor  
J. E. QUINTERO, - - - Treasurer

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Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

All communications should be addressed to COMPRESSED AIR, 26 Cortlandt St., New York.  
London Office, 92 & 93 Fleet Street.

Those who fail to receive papers promptly will please notify us at once.

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VOL. IV. APRIL, 1899. NO. 2.

With last month's issue began the Fourth Volume of this journal. When we began the publication, over three years ago, the opinion then in the minds of those interested in this paper was somewhat to the effect that compressed air was a much-abused, much-neglected thing. The unorganized efforts of those who had a sentimental as well as a business interest in the promotion of air power often met with discouragement and disappointment. The whole history was one of unending heart-burnings and defeats. The work of introducing "Air" was done in a fragmentary sort of a way, and what was everybody's work was nobody's work, and the result was as is usual under such conditions.

To-day the situation is changed, it is an enlivening scene. The advocate of compressed air may now enter any industry with a firm step and a confident mien. He has no apologies to make as a preface to his remarks. He does not fear bitter invective against the power he favors and the discussion is one aiming at co-operation and adoption. And why is this? The readers of "Compressed Air" know best of all; they have followed our work through

its three volumes with great earnestness, and we rejoice in what we believe to be the fact that there are few subscribers of ours who have not a file as complete as our own. Everywhere we hear of lectures, of papers and articles on this subject, and you may trace the influence in most cases to the columns of this journal. We have endeavored to aid those in difficulties with various interesting applications of compressed air, and we have had the pleasure of seeing some things successfully accomplished. They have been little and great. The influence of this little magazine has strengthened those who were associated with these enterprises. It has had some influence over the destinies of most of the important movements in compressed air matters.

It has taken compressed air information and scattered it widely. It has been the basis of many a student's theme in his mechanical course in the colleges. It sought to build up and keep alive the subject until it has now grown to such dimensions that it is carried along by its own momentum.

The future stands out in bold relief, and setting aside any wild schemes or delusions the chances of compressed air stand second to none. The work is not more than yet begun. Works of stupendous proportion are within the scope of compressed air. Within a few weeks street railway cars will be running on two of the most important lines in the centre of New York. These are the only lines equipped with compressed air apparatus in this country, and we believe that the installation is very much in advance of the systems used in other countries. Central compressed air power plants for giving power to the shops, offices, residences and vehicles are even now taking form in the minds of engineers. We look for developments that would at the present time be incredible. We have

faith in that hope because the attention of the genius of this country has been aroused and nothing will appease its desire until the resources of this genius will have become exhausted. New mechanical devices, more efficient means of storing, using and transmitting compressed air will make their appearance, and this means the redoubling of compressed air utility. By the cheapening of its production it will become a part of the life of the industries of the world. It will be used in the household and in connection with all departments of life.

Its history will be read in the pages of this magazine. The foundation of a great science is laid in these columns. Here are the descriptions of useful applications of compressed air showing them by the aid of photographs, drawings and other data. Accurately speaking, the enumeration of compressed air applications now number one hundred and seventy-five.

Those who want to keep informed on this subject should be on our lists and be in touch with this power which is of such growing interest and importance.

#### Central Power Plants.

Central Power Plants for distributing any kind of power, either Compressed Air, Electric or belt power, are gaining daily in popularity, and it is only a question of time until small power consumers will derive their power from Central Power Plants instead of generating the power themselves. By doing so they will dispense with the following items:—Expenses of installing boilers with their expensive settings and piping, economy in space, dispensing with the services of expensive and many times unreliable engineers; and they will obtain their power at reduced prices from Central Power Stations operated in an economical manner.

The block system of distributing power has been tried in this city for the last few years, and while working under most unfavorable conditions it has proved to be a financial success to both owners and consumers.

The table which the writer publishes in connection with this article, and which is compiled not only from theory but from actual practical results, will demonstrate the adaptability and necessity of Central Power Plants. The larger the Central Plant is the greater will be the economy.

When a Company has decided to install a Power Plant the first problem which presents itself for solution is the selection of engines and boilers and other machinery to economically develop this power. Assuming that there is sufficient floor space to install the Plant to suit the best obtainable conditions and that the purchasers have enough business sagacity to make the first cost secondary to ultimate economy, then in order to make a proper selection the following points only should be considered:—Whether to install single cylinder, compound or triple expansion engines, either condensing or non-condensing; whether, according to price of fuel, ordinary return tubular or high pressure water tube boilers would be most advisable; whether for condensing purposes, jet or surface condensers are preferable. For small plants up to 50 H. P. where the cost of fuel does not exceed \$4.00 per ton, plain slide valve engines will generally do, as they hardly require any attention, but the fuel consumption per H. P. per hour for this class of engine is exceedingly high. For plants varying from 50 to 100 H. P. per unit Meyer's cut-off engines will fill the bill. For powers varying from 100 to 500 H. P. either single or compound Corliss engines, either non-condensing or condensing, are advisable, according to conditions, it being natural that the compound condensing Corliss engines will be most economical. A reference to the table of cost of plant will show conclusively that the first cost of a plant cuts a very small figure in comparison to the cost of its operation or economy, and that the extreme difference in price between the cheapest plant for 1,000 H. P. in engines of adequate sizes shown in column No. 2 to the expensive but economical plant shown in column No. 8 and amounting to \$50,000, is more than recovered the first year in the consumption of fuel. As shown by the above table it is understood that the plant is in operation for 24 hours per day with cost of combustible at \$4.00 per ton, the figures being based on regular mining or railroad work. The cost of operating such a plant in the Western

**Comparative Table of Water and Fuel Consumption, Cost, etc., for One 1000 H. P. Central Power Plant.**

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
	Single Cylinder Plain Slide Valve Engines	Single Cylinder Meyers Cut-off Non-Condensing Engines	Compound Non-Condensing Engines	Compound Condensing Meyers Engines	Single Cylinder Non-Condensing Engines	Single Cylinder Condensing Engines	Compound Non-Condensing Engines	Compound Condensing Engines	Triple Expansion Condensing Engines
Consumption of Dry Steam per H. P., per hour...	35-40	30-35	25-30	17-20	22-25	15-18	18-23	12-15	9-11
Consumption of Dry Steam per H. P., per hour...	45	40	35	25	28	20	25	17	13
Consumption of Dry Steam for 1000 H. P. per hour...	45,000	40,000	35,000	25,000	28,000	20,000	25,000	17,000	13,000
Consumption of Feed Water per day of 24 hours...	137,000	120,000	105,000	75,000	84,000	61,000	75,000	51,000	39,000
Consumption of Feed Water per year of 360 days...	48 (200,000)	43,000,000	37,000,000	27,000,000	31,000,000	21,000,000	27,000,000	18,000,000	14,000,000
Cost of Feed Water per year at 5c. per 1000 gals...	\$2400	\$2150	\$1850	\$1350	\$1500	\$1050	\$1350	\$900	\$700
Consumption of Combustible per H. P. per hour...	5½	4¾	4	3¼	3½	2¾	2¾	1 7-10	1 3-10
Consumption of Combustible per 1000 H. P. per hour...	2.75	2.37	2.00	1.62	1.75	1.25	1.25	.85	.65
Consumption of Combustible per 1000 H. P. per day...	66	57	48	39	42	30	30	20	15½
Consumption of Combustible per year of 360 days...	29,700	20,720	17,280	14,040	15,120	10,800	10,800	7,200	5,580
Boiler Pressure in lbs. per square inch...	60-100	60-100	75-100	80-110	75-110	75-110	90-125	100-140	125-180
Type of Boilers { R. T. Return Tubular } { W. T. Water Tube }	R T	R T	R T	R T	R T or W T	R T or W T	W T	W T	W T
Square feet of heating surface to the horse power...	19-15	13-15	13-15	13-15	13-15	13-15	11	11	11
Evaporating capacity per sq. ft. of heating surface...	2½	2½	2½	2½	2½	2½	3	3	3
Boiler Horse Power required for plant...	1100	1050	1075	725	1000	700	800	500	370
Boiler Horse Power required for engine...	1200	1100	1100	875	1000	850	900	700	580
Proportion of Boiler to Engine Power...	110%	105%	107%	72%	100%	70%	80%	50%	37%
Proportion of Boiler to Engine Power...	120%	110%	110%	87%	100%	85%	90%	70%	58%
Average piston speed per minute in feet...	300-400	300-400	300-400	300-400	400-500	400-600	400-600	400-600	500-700
Cost of plant all erected with foundations, piping, smoke stacks, pumps, etc., not including cost of building nor cost of apparatus for generat- ing Compressed Air or Electric Power...	\$87,000	\$40,000	\$44,000	\$52,000	\$51,000	\$37,000	\$64,000	\$67,000	\$72,000
Cost of Fuel per H. P., per year, at \$4.00 per ton...	\$95,000	\$80,000	\$69,000	\$86,000	\$80,000	\$43,000	\$13,000	\$29,000	\$22,000

States generally exceeds the above figures, as the price of fuel, labor and incidentals is higher than that named above, and thus a higher percentage of saving will be prevalent. Economical advantages of compounding and condensing contrasted with the old style of single cylinder non-condensing engines are so patent that no company could be oblivious to them and be prejudiced in favor of buying fuel-eating plants at a slightly smaller initial expenditure.

No reference is made in the above table regarding the cost of labor to operate

Much has been said recently on the subject of distributing compressed air power for auto-mobile vehicles and manufacturing purposes, but in all that has been published nothing has been said showing the cost or giving any data to guide the investing public in this matter.

F. SCHMERBER.

#### Pneumatic Check System.

What is claimed to be a valuable feature of protection to property is the Pneumatic Watchman Check and Regulator system,

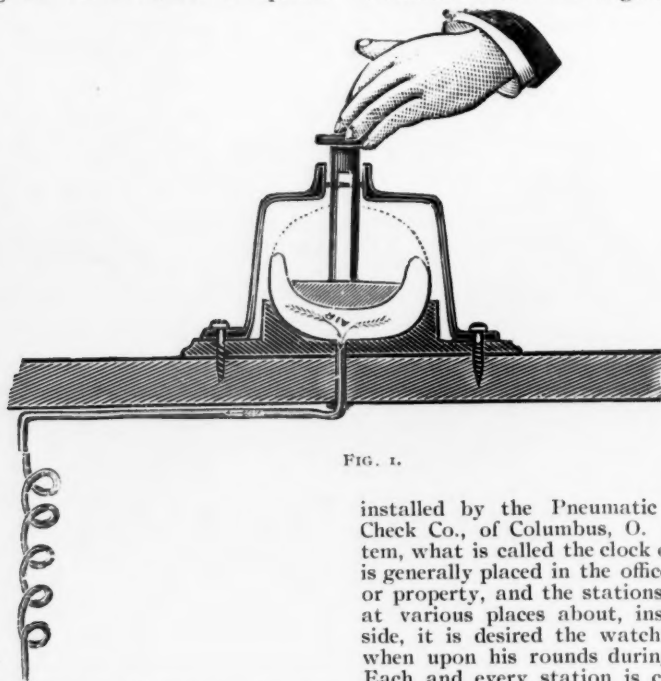


FIG. 1.

plants, the cost of labor depending entirely upon the region where plant is installed; however it should be understood that manual labor required to operate a 1,000 H. P. Central Power Plant will not exceed twice the labor required for a single 200 H. P. plant.

The table published in connection with this article ought to be of interest to any party contemplating the installation of a Compressed Air Central Power Plant for the distribution of power to small consumers.

installed by the Pneumatic Watchman Check Co., of Columbus, O. In this system, what is called the clock or Recorder, is generally placed in the office of a plant or property, and the stations are located at various places about, inside or outside, it is desired the watchman to go when upon his rounds during the night. Each and every station is connected to the Recorder in the office by means of a small metal tubing, the size of a wire. This tubing is a composition of lead and tin and zinc, there is nothing about it ever to rust, to corrode, or be affected in any way by the conditions of the atmosphere, or by heat or cold. The stations themselves are small iron boxes about three inches high. A sectional view of one of them is given in fig. 1. Inside of this iron box is a rubber ball made of a special composition of rubber, designed especially to stand the hard usage which it must

undergo. The watchman carries a key which is in the shape of a tube with a button or knob upon the end of it. He inserts this key into the station and as he does so, it pushes down or compresses the rubber ball upon the inside, and as he thus compresses the ball, it forces the air through the tubing into the clock. The station may be located as much as 2,000 or 3,000 feet away from the clock, or it can be placed at one or two feet away.

Inside of the Recorder is a set of corrugated diaphragms, made of german silver. A section of one will be noticed in fig. 1. As the air is forced from the station through the tubing into such dia-

of times. Fig. 2 is a sectional view of the Recorder. In the bottom of the Recorder is located the frame containing the diaphragms. Just above them is a deck or partition which covers over the diaphragms. On top of this deck is fastened the clock movement, which revolves the paper dial, keeping the time, the same as a clock, only there are no hands like in a clock. The whole dial face revolves. This machine, besides being used for the purpose of checking the movements and keeping a record of the night watchman, is also used in newspaper offices, to keep track of the form as it goes from one department to another. The Recorder is generally placed in the business manager's

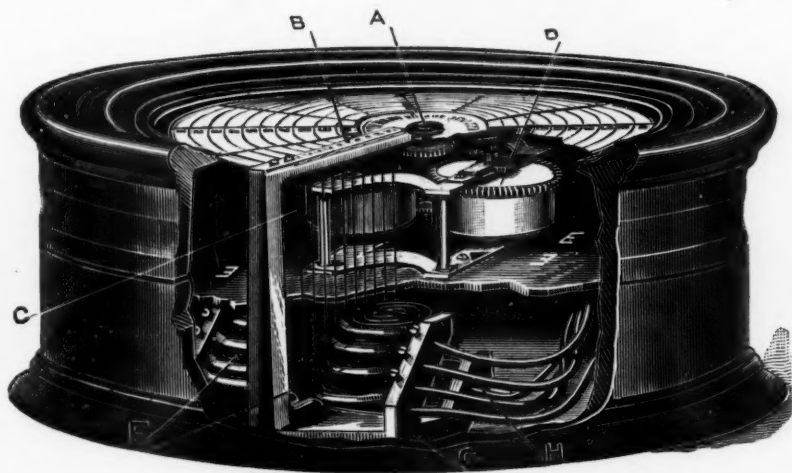


FIG. 2.

phragm, it causes the diaphragm to be inflated and rise up. On the top of the diaphragms is a small rod into which is screwed a needle and as the diaphragm is forced up by the air, it pushes the needle up, and in so doing, the needle punctures a paper dial, which dial is turned by a clock movement. Thus at any minute, day or night, whenever a key is placed into a station, it immediately forces the air through the tubing into the diaphragm, and this causes the needle to puncture in the proper spaces upon the dial showing the number of the station and also the minute it has been operated. A station may be operated any number

office. There is a station located in the composing room, one in the stereotyping room, one in the press room, and another in the circulation department. When the form leaves the composing room, the workman there simply presses a key into the station located at such place and immediately it makes a record to the exact minute on the paper dial in the Recorder in the manager's office showing just when the form left the composing room. When it is received in the stereotyping room, the workman there presses the station in that department. Also when the form leaves the stereotyping room, it shows when it was received and when it left

such department. The same also in the press room and the circulation department. This machine has been placed in newspaper offices throughout the country. Besides being in operation in hundreds of factories and manufacturing establishments throughout the country, it is also used by railroads in their freight stations and also in their shop properties wherever night watchmen are employed.

necessary to return to a storage station at short intervals, as is necessary with the high pressure systems. In this system the air is compressed to the working pressure only.

"In connection with this independent system is another source of economy, a direct gift, if so it may be called. This source is from the compressor brake, an arrangement whereby air compressors are opera-

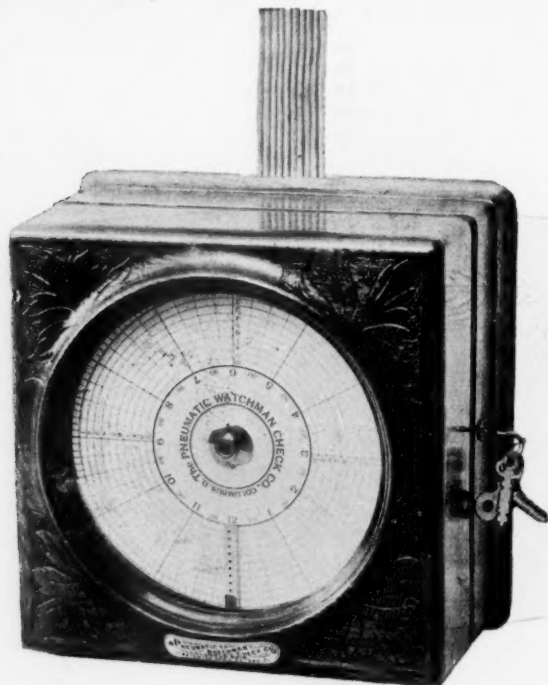


FIG. 3.

#### An Independent Motor to Utilize the Brake Energy.

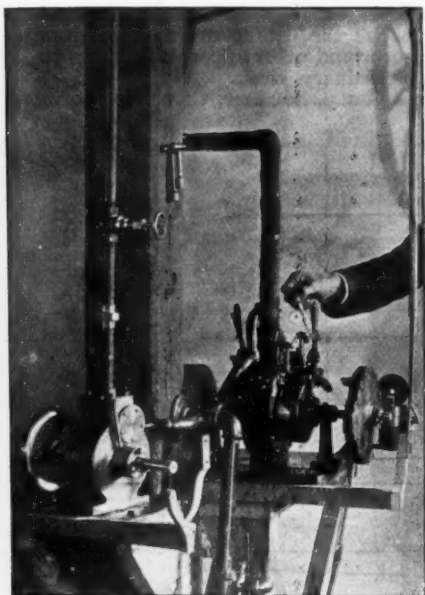
In a lecture before the Board of Trade of the City of Worcester, Mass., Mr. Merrill E. Clark, who has invented various ingenious machines, introduced and described a system of independent motor and a means of utilizing the brake energy in connection with street railway and other traction.

He described it as a self-contained, independent motor; one where it was not

tively connected with the axles of the truck, in such a manner that when the car is retarded or stopped, the energy ordinarily lost in the application of a brake is used to operate the air compressor and the air stored for subsequent use. As it requires about three times the power to start than it does in the general run, the immediate use of the air just gained by simply moving a lever is very desirable. Thus we have at our disposal for useful work the entire momentum of car or train less the friction, whenever we wish to reduce its speed.

The majority of motor vehicles are propelled from the axle. Why not stop them from the same point?

That energy due to the moving car or train, is not only available, but valuable, is illustrated by an estimate made at the Polytechnic Institute, April 29th, 1896, in



EXPERIMENTAL AIR MOTOR.

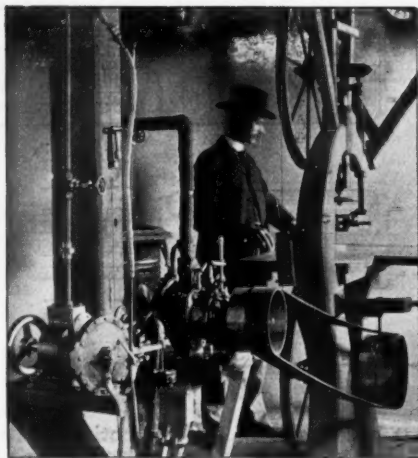
which it was shown that the work required to stop a train weighing say 424,000 pounds, in twice its length, say 800 feet, from a speed of one mile a minute, was 4,665 H. P. applied constantly during a period of 20 seconds, or 1,555 H. P. for one minute. Illustrations of this problem can be seen daily. The elevated roads in New York and Chicago are good illustrations, where the trains run about one-third of the time on the brake, drawing from the boiler or electric supply to apply them. Suppose these conditions were reversed and energy stored during the same time. The cost of operating would be materially reduced.

In the introduction of the combination air compressor, the brake compressor finds its largest development, whatever heat is lacking, due to intermittent operation of the brake, is supplied from the exhaust of the impulse cylinder.

In the ordinary oil or gas engine quite an amount of heat escapes through the exhaust, but in the compressor system the largest proportion of heat is utilized. The heat from the impact cylinder supplying the motor requirements, and the cold produced by the motors, is turned back to do service at the combustion cylinders. Thus the exhaust is both utilized and muffled. As an illustration of this, it is shown that the exhaust from air motors in Paris, is used for refrigerating purposes and the exhaust from gas engines in Pittsburg is used for heating purposes.

To harness an external combustion engine direct to the axle of a car or locomotive offers difficulties at once, an impact sufficient to start from a point of rest, would wreck the machinery. We can secure the energy, but the natural travel of the pistons would be many times faster than the speed of the crank pin on the Empire State express engine running at its best.

The combination compressor here advocated is so constructed that a very uniform pressure is maintained between the combustion and air cylinders, the result of which secures to this system, not only the



MOTOR OPERATING BAND SAW.

highest attainment of the steam engine, but reduces impact to pressure, in the most efficient form. For when the predetermined working air pressure is reached, the supply of fuel is cut off, and the machine stops, not simply runs idle, which occasions waste to a considerable extent

and when the pressure falls below the desired point, the compressor automatically starts, restores and maintains the said working pressure.

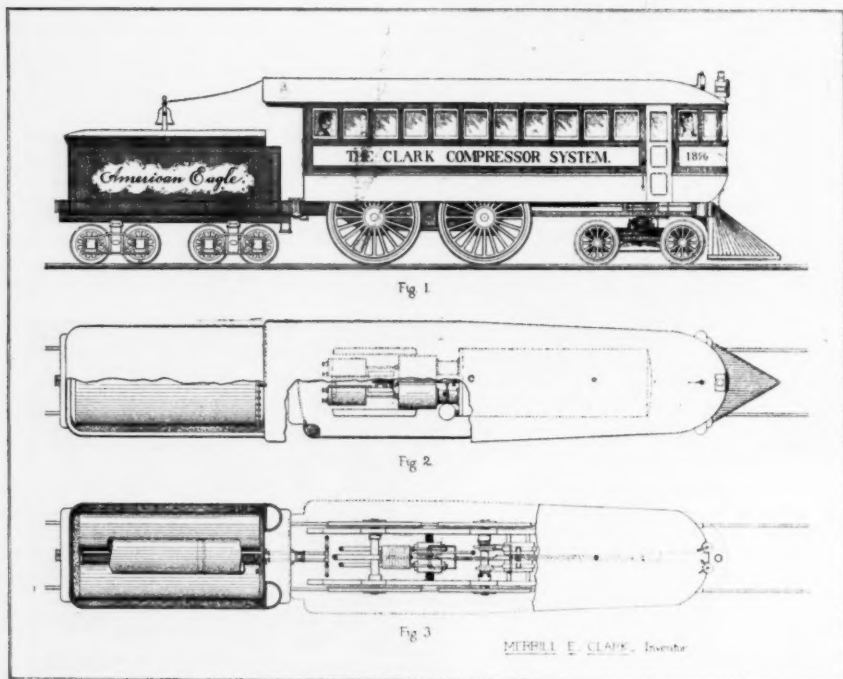
In this way all waste from the safety valves with its attendant disagreeable noise is avoided.

It will be noticed that in this system the fire-box, flue system, cinder chamber and smoke stack are dispensed with and locomotives in use at the present time can be readily equipped with this system, at comparatively small expense.

tage of steam, from maximum pressure, to multiplied expansion, with a balance in its favor. We look to see in the near future the perfected motors not only on our streets but making the longer journeys on land and sea. Not only with the speed of the wind, but with the annoying smoke and cinders eliminated.

At this writing, we are not prepared to publish the details of construction of the motor and other apparatus, owing to the preliminary work.

We will say, however, that this motor



THE INDEPENDENT MOTOR SYSTEM.

What is here said of the locomotive is applicable to the steamship, where this system can be used with great efficiency and economy.

When we consider the force developed in the internal combustion cylinder at small expense, and know that this power can be greatly increased, when the mechanism is favorable to transmit it with safety, that compressed air possesses the advan-

consists of a plurality of internal combustion and air cylinders with their axis in alignment for the purpose of reducing friction to the minimum point.

These several cylinders are arranged to develop the highest power in the combustion cylinder to correspond to the highest performance of the air cylinder, thus creating a practically perfect and uniform power during a whole revolution.

This point is certainly worthy of consideration in street railway practice where shocks or vibrations are to be avoided."

**An account of the attempts to introduce  
Compressed Air for steering vessels.**

The first application of compressed air for steering vessels was made about fifteen years ago; by permission of the Government, on the U. S. Steamship "Tallapoosa," an old vessel which was sent to the South American coast. As a system it proved satisfactory, according to the reports officially made to the Bureau of Navigation, but some mechanical defects were needed to be remedied which could not be done at that distance. The vessel was afterwards condemned and sold. The principle of compressed air for steering was fully endorsed, and the cost of the test was allowed to the interested parties. The next application was made on the old Dominion S. S. "Seneca," and the reports of its captain were very satisfactory. I quote from the reports of Capt. Geo. M. Walker, 1887:

"After using it for six months during which time it cost nothing for repairs, giving the most complete and perfect confidence in controlling the ship in storm and fogs, dark nights and through fleets of vessels. It must when properly known come into general use." It was used for two years with gratifying results. The gear on the S.S. "Seneca" afterwards became the property of the Pneumatic Steering Gear and Mfg. Co. of New York, who obtained control of the patents.

While trying to improve some mechanical defects, it was ordered off the vessel as it was ascertained by the influence of a steam steering company who afterwards put their own steering gear on board.

The reports to the Government made in 1887 recommended the system to the favorable consideration of the Navy Department, by the members of the Pneumatic Gun Carriage Co. of Washington, D. C. In the meanwhile the Pneumatic Steering Gear Co. allowed experiments to be made, mechanically different, for the Staten Island Ferry Boat, which proved to be worthless. After spending considerable money on the experiment, that gear with the one taken from the "Seneca" was sent to the Morgan Iron Works of N. Y. for the purpose of being made mechanically useful, and as

far as possible perfect, but owing to lack of means at the time to carry out their purpose, the Company have virtually done nothing since. Later permission was given to the Pneumatic Gun Carriage Co. of Washington, D. C., to use their devices, the company having made a contract with the Government for the entire system, on the U. S. Monitor "Terror." Both companies are now waiting for a full endorsement of the system with order for other vessels, for which recommendations have been made and resolutions offered in Congress.

The benefits of the system are: A firmer and greater impression on the valves forming a cushion to the rudder head. It also ventilates the entire ship. It is noiseless and does away with odors and hot steam pipes, and the danger from their bursting. There is no possibility of freezing from condensation and the exhaust reduces the temperature. Engineer T. W. Kinkaid of the U. S. Navy in an article in the Journal of the American Society of Naval Engineers (Vol. IV, No. 1), says: The pneumatic system is simple and powerful and possesses advantages over the hydraulic and electric systems. There is no burning-out of fuses as with electricity and no danger from burns or electric shocks nor from drenching as with the hydraulic system. There is no increase of temperature and the exhaust improves the ventilation, all of which things are advantages over steam and hydraulic and electric systems.

On the trial trip of the Monitor "Terror" the rudder was turned from hard-a-port to hard-a-starboard in six (6) seconds 68 degrees. The area of the rudder is eighty-two sq. feet, the pressure of 125 lbs. per sq. inch is maintained by one air compressor. A pressure was maintained not below 30 lbs. and not above 60 lbs. for steering.

Air leakage has been entirely overcome by a process which has been tried successfully by the Cramps, of Philadelphia, Pa.

The final report further says that the system is quick and accurate and the engine does not get out of order, and the engine room is free from noise, dust, heat, moisture and shock.

The system has been endorsed by Commodore G. W. Melville, Engineer-in-Chief U. S. N. The Naval Board endorses it as being superior to all others, using the word excellent. Rear-Admiral Mathews endorses it, and Chief Constructor Hick-

born reiterates all that has been said and recommends it.

Interested parties, with the experience of the past few years, are preparing for further superiority in the use of compressed air for steering vessels in the formation of a new company, controlling all improvements for the purpose.

The system is attracting much attention in England.

JOS. C. WALCOTT,

President,

Pneumatic Steering Gear and Mfg. Co.

### Mechanical Application of Compressed Air.

We have had this week a significant illustration of the scientific interest which is taken in the utilization of this force. There is, perhaps, no institute in the United States which has more speedily recognized new commercial tendencies and utilizations due to scientific discovery than the Franklin Institute of Philadelphia. This institution set apart one evening recently for the discussion of the various uses to which compressed air is now put for commercial ends and for a discussion as to the range in the future which the utilization of this force may find in commerce and in manufacturing. Men of high scientific authority of New York, Chicago, Philadelphia and other centers in scientific study took part in this discussion.

#### USE IN MINOR INDUSTRIES.

There was agreement that for a thousand and one industries, many of them of delicate and intricate character, compressed air is to furnish the most satisfactory and economical of all power-producing agents. In fact, it seems to cover the whole range of minor industrial vocations, especially some that hitherto have been presumed to be adapted only to hand power. When the other day workmen painted the whole substructure of the Washington Bridge by means of compressed air apparatus and did it satisfactorily, there was amazement expressed here that this force could be put to such use.

The master mechanic of the Erie railroad laughed contemptuously when he was told that an air apparatus would tamp his railroad tracks more speedily and more cheaply than it could be done by hand power. This is something which

master mechanics have always believed no apparatus excepting the tamping iron and the brawny arms of the laborer could satisfactorily do. Now, the president of the Erie tells his friends that compressed air apparatus will do this better than hand power. These are only illustrations of the wide range of the mechanical use mentioned at the Franklin Institute meeting. It was also said that compressed air would solve the problem of perfect food refrigeration in the tropics, and it is hinted that before very long there are to be established not only in Cuba and in Porto Rico, but in Manila, American apparatus designed to do this work.

No one believes that compressed air is to be such a competitor of electric current as to supplant that. There are many things that electricity can do cheaper and better than any compressed air apparatus yet invented is able to do. It is more likely to supplement the electric current.

It is true that compressed air force may be seriously threatened, by and by, by liquid air, the possibilities in which seem to be so great as to suggest complete revolution in the production and utilization of power. But that day is remote, although Mr. Tripler has demonstrated to the scientists of authority here that he is no quack, no maker of ingenious, interesting, but commercially useless philosophical experiments, but is carrying on a line of investigation worthy of the approval and encouragement of all scientists and of the commercial world as well.

From 1881 to the present day we were in what may be called the era of the commercial development of electricity for other than telegraphic purposes. This year we seem to be entering into an era to be characterized by the commercial utilization of compressed air, not so much in competition with electricity, but in sympathy with and supplemental to it.—"Holland" in the Phila. Press.

#### Ratios of Areas of Inlet and Outlet Valves to that of the Air Cylinder.

In an air compressor what are the correct ratios of areas of inlet and outlet valves to that of the air cylinder?—Ajax, Baltimore, Md.

There is no such thing as correct ratios in cases of this character. We can

only say what seems to be the most common and approved practice, or what experience has demonstrated to be, upon the whole, the best. Valve areas on a compressor depend largely upon the style of valve employed, that is whether the opening is one concentrated area, and also whether the valve is held open to get all this area throughout the stroke. Roughly speaking, about 5,000 feet per minute velocity for the air passing the valve gives good results, a slow running machine, that is one having low piston speed, hence requiring a smaller valve area than a fast running machine. In compressors using the "piston inlet" valve and having from 300 to 350 feet piston speed the inlet area is from 5 to 6 per cent., this area, however, being concentrated and positive for the whole length of the stroke. In this case the velocity of the air is 7,000 feet per minute, but good results are shown. On large compressors, where the steam cylinders are of the Corliss type, and the piston speeds are as high as 500 to 600 feet per minute, the inlet areas, with the same type of valve as before, range from  $6\frac{1}{2}$  to 7 per cent., and the discharge areas (poppet valves) from 10 to 12 per cent., giving about the same velocity in the air passages as with the slower machines. On machines having poppet valves all around probably 12 per cent. of area is necessary, as machines with but from 7 to 10 per cent. area have shown considerable vacuum on the inlet, the springs tending to hold the valves partially closed and reducing the practical area. About 10 per cent. area for both the inlet and discharge valves should be sufficient for almost any good style of valves and for piston speeds not exceeding 400 feet per minute. The area of the discharge valves should not be less than that of the inlet valves, as, although the volume of air passing the discharge valves is of course much less than that passing the inlet valves, the time allowed for the passage is also proportionately less. While the inlet valves are open, or should be, during the whole of the intake stroke, the discharge valves can be open only for one-fourth or fifth, or other small portion of the stroke, according to the pressure. For most of the above we are indebted to Mr. William Prellwitz, M. E., chief draftsman of the Ingersoll-Sergeant Drill Company, Easton Pa., and it is based upon the practice and experience of that company.—Am. Mach.

### Compressed Air Enterprises.

The American Air Power Company's Undertaking on the 28th and 29th Street Railway, City of New York.

By George C. Densmore, C. E.

The application of compressed air to the industrial arts has always been a fascinating field of effort to a certain class of inventors, and, with a zeal not born of knowledge, and the densest ignorance of the physical laws controlling the processes they proposed, they have met inevitable and complete failure, and the highway of mechanical progress is strewn with abandoned schemes for the use of compressed air. Yet they have not toiled in vain. Failures along certain lines have simply shown that they were not the proper ones, and by no means determine that success may not be achieved along other and better chosen ones. Few inventions have sprung full-fledged from the brain of the inventor, like Minerva from the brain of Jupiter. Crude and early devices have been the stepping stones through the various stages of evolution to the perfected product. When the Marquis of Worcester invented and put in operation, about the year 1660, at Raglan Castle, Ireland, his famous machine for raising water by the aid of steam, and which he described, in a pamphlet bearing the pompous and highfalutin title, "An Exact and True Definition of the Most Stupendous Water-Commanding Engine, Invented by the Right Honorable (and deservedly to be praised and admired) Edward Somerset, Lord Marquis of Worcester," he became the inaugurator of the era of steam; for his early and simple machine led up, through the engines of Savery and Newcomen, to the perfected, double-acting, condensing engine of Watt, whose advent, at the close of the last century, has so completely revolutionized the industrial and social life of the world. So compressed air, from small beginnings, in the obscurity of the past, has been exploited in a variety of fields, with marked success in some and emphatic failure in others.

For use in tunnels and mines, for driving drills and pumps, it is the ideal power—and then exhaust helps to improve ventilation and lowers temperature. For air-brake service on the railroads of the country it is the only available force; and, although the air-compressors on locomotives

use steam extravagantly, yet this extravagance continues uncorrected, and almost unnoticed. Its measure of success as a method of distributing power over an extended district in Paris has been a large one. It is largely used in the railroad shops for pneumatic hoists; and the use of small compressors for drawing beer is also large.

It is only when compressed air is taken from these undisputed fields, and entered as an applicant for consideration as a motive power for railway traction in competition with steam, the trolley and the electric conduit and cable, that opinions of its value vary, and its availability is questioned. The strange thing about it is that engineers reach conclusions that are diametrically opposed from the same set of facts; for there is no force that is better understood than compressed air. Large sums of money have been spent under the direction of competent engineers in measuring all of its changes of temperature and volume in its passage from the engine-room, through the compressor and the storage reservoir, to the exhaust of the motor. All of its economics and extravagance have been considered and weighed, and are matters of record; yet the following extracts will show how varied are the judgments of two men with exceptional opportunities, large experience and unquestionable ability, to help them to correct conclusions. In the *Journal of the Franklin Institute* of 1897 Prof. Herman Haupt writes:

"Compressed air motors have long since passed the experimental stage. They have been running for two years at Rome, N. Y., and, through the kindness of the officials of the New York Central Railroad, have been repeatedly allowed to run on the main track, when a speed has been attained of 30 miles an hour, with wheels of only 26 inches diameter.

"It should be obvious to every person of intelligence that a compressed air motor can be planned to fulfil any conditions or perform any service within the capacity of the steam locomotive. Speed requires large wheels, length of run large storage. High grades and heavy trains require large cylinders. The motor must be adapted to its work, and fulfil the conditions of its service."

About the same time the New York Evening Post published an interview with M. Adbank, a prominent consulting en-

gineer of Paris, then on a short business trip to this country. M. Adbank has had large experience of different methods of urban car traction. In this interview he said:

"In France, after a trial of every conceivable mode of traction, the problem is definitely solved by the adoption of the trolley electric system. By this I do not mean the overhead trolley exclusively, but, in the crowded parts of the city, the underground trolley as well.

"We got our tram cars from the United States about twenty-five years ago. Previous to that we had only omnibuses. I may add that we still have many omnibuses. You have, in New York, banished the omnibuses from all of your thoroughfares except Fifth Avenue. In Paris the omnibus alone is permitted in the crowded centers of the city, and there is no immediate prospect of a change in any of those central boulevards. The Parisian people have always had, and still have, an intense repugnance to seeing their principal streets and boulevards seamed with car-tracks. The tram cars we got from America remained in universal use throughout France until three years ago. Then only did the general displacement, by electric cars, begin. It is not to be inferred from this that we were supine in the matter. On the contrary, we were more diligent in experimentation than probably any other nation. We were behind you, however, in experimenting with electricity, and when we saw that you had advanced it to a point when its feasibility would be speedily demonstrated in a practical way, we rather held back, and let you decide the question for us. But in trying other modes of traction we were before you. We have most thoroughly tested ordinary steam, superheated steam and compressed air. There are a few short lines in France, Belgium, Spain, and other European countries, still operated by the superheated steam system, but that system is dead; it is only continued because of the great cost in changing it, and because, in the peculiar localities in which it is used, the expense of it does not seem to the managers to be justified.

"The compressed air system is in larger use, but the same judgment may be pronounced upon that. This subject is one of importance to you, because you seem to be looking to this system with considerable hope just when it has been practi-

cally discarded in France as undesirable. There, as here, it was hailed by a good many people as the solution of the whole problem, and it held its own very well until the appearance of electric traction. Not a few companies in France were prepared to introduce the compressed air system when the development of electric traction in this country, and its first successful introduction in France, caused them to suspend action until they had further watched the operation of electricity. Their final decision was in favor of the latter system. The status of the several systems in France is concisely shown by the fact that, beginning only three years ago, we have built five hundred miles of trolley road, while of the compressed air lines there are only forty-one, although the system was introduced in 1881, and a still smaller number of the superheated steam system.

"There are two main reasons why compressed air traction has gone to the wall, and electric traction has come into such wide use—the greater cheapness of the latter, and its greater simplicity. The compressed air system involves a large number of transformations of energy whereby power is lost, and the expense of operation greatly increased. The purely traction cost of this system is ten and a half cents per car mile; the purely traction cost of the trolley is five and a half cents per car mile, just about half. Again, the compressed air system involves mechanism of a highly complicated order. There are fifty moving parts in an air motor car; in the electric there are only the armature and the gear. Whatever is complicated is, upon general principles, objectionable in mechanics; the simpler a thing is the more desirable and useful. Complicated constructions get out of order easily, and the cost of repairs is great. The repair cost of the air motor cars in France has been something enormous. The air motors proposed in your country may have some improvements over the method invented by M. Mekarski in France; but they cannot be radical. I confess that I did not examine the cars you have in operation here on 125th street, but the reason is that, as an engineer, I have studied the principle thoroughly, and know that it is incapable of any substantial development. So far as I have heard, the only difference of any moment between the air motors here and those in France is that here you

propose to operate under a very much higher pressure of air than we use there. But this, while not increasing the efficiency of the system to an adequate extent, and not removing the objections founded upon complexity and cost, is highly dangerous. With the much lower pressure used in France we have had many accidents. Tanks, pipes and valve boxes have, at one time or another, exploded. I have personally seen two explosions. What would be the result with the pressure doubled? Since the practicability of the trolley was demonstrated there has not been a single compressed air line added to those already in France."

—That one fresh from the field of the most pronounced success of the air motor should be so candid in expressing a preference for the electric motor certainly shows that the trend of public opinion is in that direction. And it remains to be seen whether the friends of compressed air can change it. The Mekarski motor first appeared upon the streets of Paris in 1876, and the trial motors of Hardie design were placed upon the tracks of the Second Avenue Railroad, New York, in 1879. They are constructed on quite similar lines, and both show that their designers had very clear conceptions of the problem in hand, and very large has been their measure of success. Both have overcome the difficulties encountered in using air exhaustively by increased storage pressure and reheating. The Hardie motor has encountered some hostile criticism on account of being outside and direct-connected, like a locomotive, a criticism which its French prototype has largely escaped, though very similar in its detail of construction.

While retaining the valuable features of the Hardie and Mekarski motors, inventors have been trying to eliminate the objectionable outside connections by the production of the successful geared motor, which will render possible the placing of all of the moving parts of the motor directly under the body of the car.

Messrs. Hoadley and Knight invented a motor which bears their name and was fairly successful, and is now made by the American Air Power Company, at their shops, at the foot of West 24th Street, City of New York, for use by the Metropolitan Street Railway Company on their 28th and 29th street line, with its detail of construction somewhat modified and

perfected. It is, without doubt, the best air motor yet produced. Whether it can attain to the economy of air consumption of a direct-connected motor is doubtful.

This company is equipping twenty Brill (4-wheel truck) cars with these motors. A double motor is placed over each end of the truck with its double crank shaft set parallel to the axle of the car, and geared to it by means of a pinion meshing into a spur wheel on the axle. Proportion of gearing—pinion, 1; spur wheel,  $2\frac{1}{2}$ . Three storage reservoirs, 21 feet long and 9 inches diameter and 5-16 of an inch thick, charged with air at 2,500 lbs. pressure per square inch, are placed under each of the car seats; each cylinder weighs 300 pounds, has a capacity of  $7\frac{1}{2}$  cubic feet of air, weighing, at 2,500 pounds pressure, 50 pounds. Directly under the center of the bottom of the car is a steel cylinder about 24 inches in diameter, whose axis is placed perpendicular to the axis of the car. This is the hot water reservoir, and its length is equal to the width of the car. The pressure upon this cylinder is 300 pounds per square inch. It is charged with hot water at a temperature, due to the pressure, which is above 400 degrees Fahr. The air passes from the storage reservoir through a valve which reduces its pressure; thence through the hot water, which raises its pressure to 150 pounds; thence to the cylinders of the motor of the forward axle, when it expands down to 75 pounds; thence to the cylinders of the motors over the rear axle, and expands to the atmosphere.

The company is erecting a 1000 H. P. compressor at their shops for use in charging the storage reservoirs of the cars. It is a vertical Ingersoll-Sergeant compressor, operated by a Reynolds-Corliss engine, made by the E. P. Allis Company, of Milwaukee, Wis. This compressor is 60 feet high, and operates through four stages of compression and cooling—first to 60 pounds; then to 300 pounds; then to 900 pounds, and then to 2,500 pounds. The boilers in the compressor-room are two 500 H. P. Babcock and Wilcox water tubular boilers.

This is the most extensive trial of compressed air yet made in this country, and will furnish data for a more correct estimate of its value as a motive force for traction. It will be watched with keen interest by all engineers. It is expected that two cars will be running between the 1st and 10th of March. Whether the pub-

lic will take kindly to the enormous pressure carried upon the air reservoirs placed under the slats remains to be seen. That they will not dismiss all consideration of them, in the airy, breezy fashion of their advocates, goes without saying. When we shall have the material at hand for a more extended and technical consideration of this subject, we may revert to it.

—*Municipal and Railway Record.*

## PATENTS GRANTED FEB., 1899.

618,959.—Air Compressor. Lowell & Brown, Somerville, Mass.

A closed tank has separate air and water valve-controlled inlets and outlets. A lever, pivoted intermediate of its ends, is connected at one end by a rod with the valve controlling the water-inlet, while a similar rod connects the other end of said lever to the valve controlling the water outlet. A float is designed to slide on this latter rod and means are provided for holding the lever in an elevated or depressed position.

619,381.—Air Brake. R. E. Wynn, Barnard, Indiana.

This invention comprises an air-reservoir, a pump and its piston, and a connection between the piston and a crank or eccentric on an axle. Devices are provided for throwing the crank into and out of operation, such devices being operated by valves controlled by a diaphragm. The devices are thus shifted automatically as the air pressure within the reservoir reaches pre-determined limits. A pipe having a three-way cock therein leads from the reservoir to a brake-operating cylinder.

619,483.—Apparatus for Heating Air. James Higginbottom, Liverpool, England.

Two conduits have depressed end portions containing water, and communicate by a trap connection, above which latter each conduit is provided with an inlet opening for steam and an outlet opening for water. One of the conduits contains an open-bottomed shield which covers the water-outlet opening and extends down into the depressed portion of the conduit. Heating pipes connect with the two conduits and with each other.

620,554.—Air and Gas Engine. J. W. Eisenhuth, New York, N. Y.

This engine relates to the class adapted to use mixtures of air and water or oil to effect the operation of the pistons. A main shaft is provided with crank-portions having three pistons connected thereto. One of the pistons is run by means of a gaseous or explosive mixture; a second is operated by compressed air, while a third piston is used as a compressor for compressing a gaseous mixture and forcing the same into the gas cylinder. The cranks upon the crank-shaft are arranged at different angles with respect to each other so as to make the movement of the engine more even. A small air-pump is operated by the engine for compressing the air to be used in the compressed air cylinder and the heated exhaust from the gas cylinder may be employed to expand the said air after it is compressed and give it further explosive power. Suitable valves are also operated by gearing connected with the main shaft for controlling the compression and inlet of the gaseous mixture as well as the supply of compressed air for running the engine.

# COMPRESSED AIR.

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## ALPHABETICAL LIST OF PNEUMATIC INVENTIONS.

For which United States patents have been granted. Prepared for COMPRESSED AIR from official records by GRAFTON L. MCGILL.

APPLIANCE.	NAME OF INVENTOR.	DATE OF ISSUE.	No.
Air Brake.....	Schenck .....	August 7, 1894	524,073
" .....	" .....	Dec. 18, 1894	531,137
" .....	" .....	Jan. 22, 1895	532,914
" .....	Sennett et al .....	Jan. 10, 1893	489,763
" .....	" .....	March 19, 1895	536,000
" .....	Shallenberger .....	Oct. 17, 1893	506,739
" .....	Shearwood .....	Jan. 5, 1897	574,498
" .....	Shortridge .....	March 2, 1897	578,168
" .....	Shortt .....	Dec. 11, 1894	530,904
" .....	" .....	April 30, 1895	538,547
" .....	" .....	April 30, 1895	538,551
" .....	" .....	April 30, 1895	538,544
" .....	" .....	April 30, 1895	538,549
" .....	et al .....	April 30, 1895	538,540
" .....	Steedman .....	July 16, 1895	542,948
" .....	Stewart .....	March 27, 1894	517,250
" .....	Thayer et al .....	August 21, 1883	283,534
" .....	Thompson .....	Sept. 3, 1895	545,749
" .....	" .....	Nov. 17, 1896	571,708
" .....	Tower et al .....	April 30, 1895	538,299
" .....	Trapp .....	July 6, 1897	585,927
" .....	Trott .....	March 19, 1895	536,002
" .....	Van Dusen .....	Dec. 26, 1882	269,747
" .....	Voorhees .....	August 7, 1894	524,050
" .....	" .....	Sept. 11, 1894	525,876
" .....	Waite .....	Nov. 10, 1891	463,085
" .....	Walker .....	Oct. 7, 1890	438,038
" .....	et al .....	Oct. 13, 1896	569,258
" .....	Wands .....	May 17, 1898	604,244
" .....	Ward .....	Jan. 30, 1872	123,312
" .....	Wessels et al .....	Oct. 22, 1895	548,335
" .....	Westinghouse .....	April 13, 1869	88,929
" .....	" .....	Jan. 23, 1872	123,067
" .....	" .....	March 5, 1872	124,404
" .....	" .....	March 5, 1872	124,405
" .....	" .....	Oct. 28, 1873	144,005
" .....	" .....	Oct. 27, 1874	156,323
" .....	et al .....	April 27, 1875	162,465
" .....	" .....	April 11, 1876	175,886
" .....	" .....	July 25, 1876	180,179
" .....	" .....	April 22, 1879	214,603
" .....	" .....	June 28, 1881	243,415
" .....	" .....	August 2, 1881	245,109
" .....	" .....	August 2, 1881	245,110
" .....	" .....	Jan. 9, 1883	270,528
" .....	" .....	March 29, 1887	360,070
" .....	" .....	Feb. 18, 1890	421,641
" .....	" .....	March 24, 1891	448,827
" .....	et al .....	Oct. 20, 1891	461,779
" .....	" .....	March 31, 1896	557,461
" .....	et al .....	Oct. 26, 1897	592,461
" .....	Wheeler .....	Sept. 24, 1895	546,835
" .....	White .....	April 23, 1895	538,002

## ALPHABETICAL LIST OF PNEUMATIC INVENTIONS.—Cont.

APPLIANCE.	NAME OF INVENTOR.	DATE OF ISSUE.	No.
" .....	Williets .....	June 2, 1896	561,301
" .....	Willis .....	August 19, 1884	303,777
" .....	Williams .....	Dec. 4, 1888	393,950
" .....	" .....	Nov. 25, 1890	441,526
" .....	" .....	July 1, 1890	431,303
" .....	" .....	July 8, 1890	431,790
" .....	" .....	Nov. 18, 1890	11,124
" .....	" .....	July 1, 1890	431,304
" .....	Willson .....	March 20, 1894	516,692
" .....	Winters .....	Nov. 23, 1897	594,228
" .....	Wisner .....	Jan. 26, 1886	335,094
" .....	" .....	Feb. 24, 1891	446,908
" .....	Zenke .....	Nov. 17, 1896	571,736

## COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSED AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz., all communications should be written on one side of the paper only; they should be short and to the point.

## Editor Compressed Air:

Could you give me any advice or tell me if a triple expansion or a heavy duty Corliss engine can be run by compressed air the same as with steam? By answering the above you will confer a favor by addressing

HARRY POPE,

Hoboken, N. J.

An engine operated by steam can be operated advantageously by compressed air, if such power is available. However, certain points must be taken into consideration. If a single cylinder engine is operated by compressed air, it is always advisable to reheat the air, say to 300 degrees at least, before utilizing the same. For a compound engine of any type, a reheater will be required to reheat the air before entering the high pressure cylinder, and as the air will lose a considerable amount of heat, on account of expansion in the high pressure cylinder, this loss of heat being proportional to the degree of

expansion, a second reheater will be required between the high and low pressure cylinders, not only to increase the volume of air exhausted by the high pressure cylinder, but also in order to raise its temperature, as the final temperature of low pressure cylinders of compound engines, in many cases, would be below zero, and under such conditions proper lubricating could not be obtained. It would in no case be advisable to operate triple expansion steam engines by compressed air, as the low pressure cylinder of a triple expansion engine derives its power almost entirely from the vacuum of the condenser, the mean effective pressure of a low pressure cylinder of a triple expansion engine being generally two or three pounds below the atmosphere, vacuum not taken into consideration. However, special triple expansion engines could be built to operate by compressed air, but a special ratio of cylinders would have to be established, and the initial air pressure to operate such an engine would have to be at least 300 pounds to the square inch, while no gain in economy would be obtained over the compound engine worked by air, provided the compound engine cylinders would be of such proportion as to obtain an atmospheric terminal pressure in low pressure cylinder.

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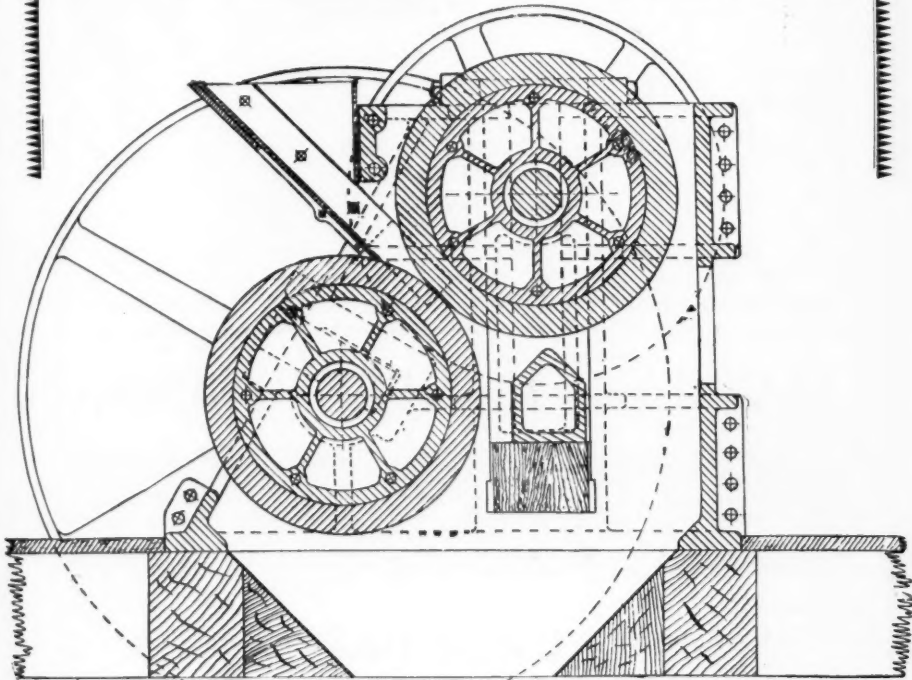
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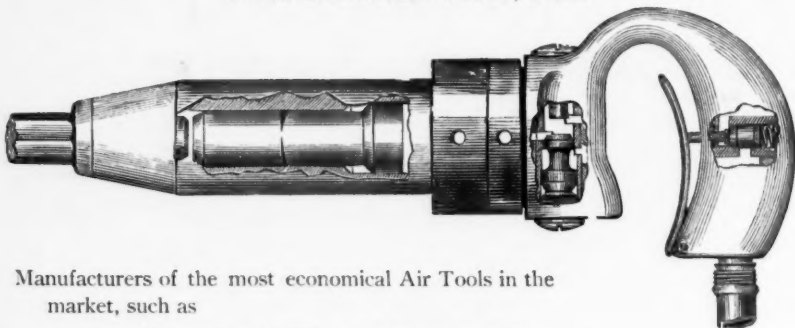
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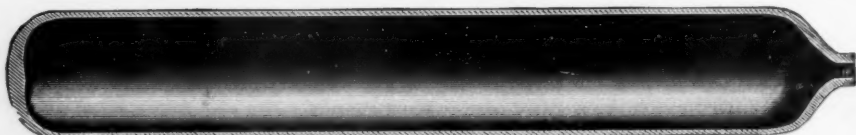
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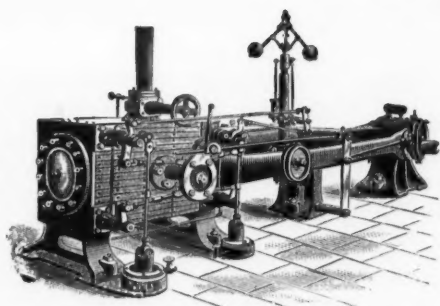
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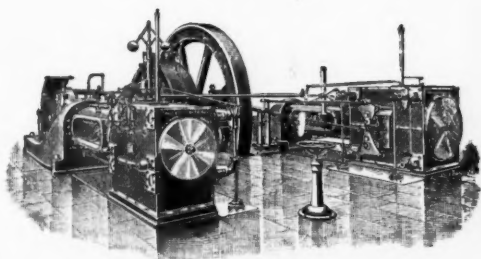
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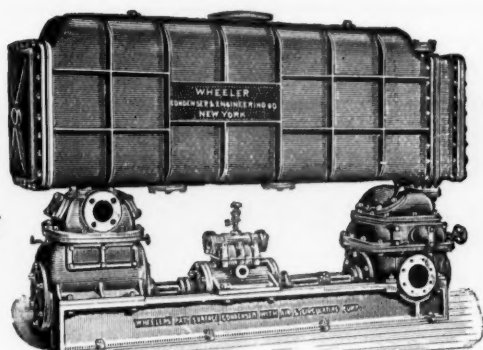
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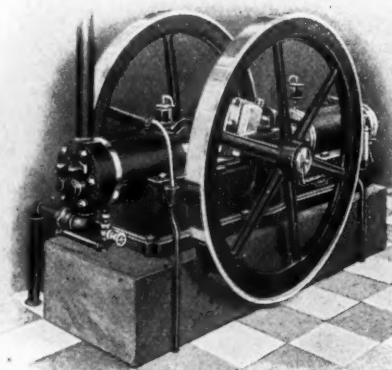
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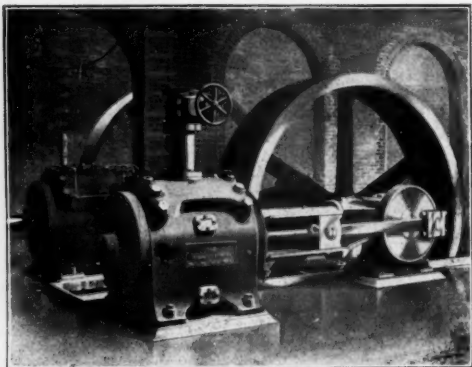
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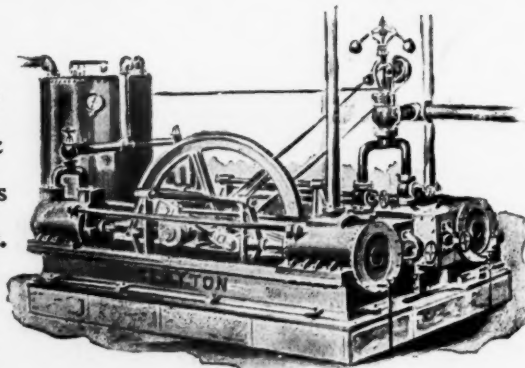
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